

WASHINGTON

SCIENCE TRENDS

HIGHLIGHTS

- ADVANCED FLIGHT STRUCTURES
- MISSILE CANCELLATIONS
- INVENTIONS WANTED
- PUBLICATION CHECKLIST

Vol. IV, No. 17

July 11, 1960

* ADVANCED FLIGHT STRUCTURES

National Aeronautics and Space Administration officials and advisors have set forth a comprehensive program of proposed research and development in the field of structures for advanced aircraft, missiles, satellites, and space vehicles. Here is a summary of their recommendations:

Important Areas for Research Emphasis

Ø Environment is a major factor in determining both the loadings to which the structure is subjected and, in many cases, the response of the structure to these loadings. Continued emphasis must therefore be placed upon the determination of the environmental characteristics of importance to flight structures as indicated below:

Within the Earth's Atmosphere -- (1) Improved knowledge of turbulence at both very low and very high altitudes. (2) Characteristics of transmission of acoustic excitations as from boundary layer turbulence and from jet and rocket exhausts. (3) Intensities of energetic particle radiation to determine the significance of this radiation for manned airborne and space vehicles above 50,000 ft. altitude.

Beyond the Earth's Atmosphere -- Emphasis needs to be placed upon the engineering aspects of structural design to the environment, not simply upon the determination of the environment per se. Problem areas to be particularly investigated include: (1) Measurements of meteoroid penetration and erosion; (2) Erosion by sputtering. (3) Effect of radiation and hard vacuum on material properties, particularly fatigue strength. (4) Effects of radiation and hard vacuum on friction and lubrication.

Environment of Other Planets -- Before landings can be made safely on other planets, the characteristics of their atmospheres and surfaces must be determined in sufficient detail for use in engineering design.

Ø Environment Control -- Once the environment has been established, means must be found to design vehicles which are capable of operating in this environment without damage to themselves or their contents. Some problem areas are so well established that immediate research is called for. Among the latter are:

Within the Earth's or Other Planetary Atmosphere -- Development of wide-band thermal protection systems to permit a significant broadening of the flight corridor.

(Continued)

ADVANCED FLIGHT STRUCTURES (Continued)

In Space -- (1) The determination of shielding requirements for protecting biological payloads and the integration of such requirements with other functions of the structure. (2) Protection of structural elements from hypervelocity impacts from meteoroids and micrometeoroids. (3) Protection of the structure from material erosion due to sputtering and the effects of hard vacuum. (4) Evaluation of effects produced because the hard vacuum, erosion, and radiation may occur simultaneously.

Configuration Studies

Atmospheric Flight Vehicles -- (1) Optimization of structural configuration, trajectory control, and thermal protection in order to reduce the aerodynamic heating. (2) Determination of the most efficient hot and cold load-carrying structure of all types including structures of high-temperature metallic fabrics. (3) Optimum structural configurations for large boosters, including fabrication, transportation, and erection considerations. (4) Determination of best methods of diffusing concentrated loads into thin shell structures.

Space Vehicles -- (1) Determination of desirable structural configurations for low-density structures of large surface areas such as large antennas, reflectors, and solar sails, particularly those to be erected in space. (2) Development of new energy-absorbing systems for landing, and evaluation of such systems relative to those now available.

Analytical Methods and Design Allowables -- The areas that have been identified here as requiring great improvements in methods of analysis and in methods of determining allowable values for design are in the following categories:

Thin Shell Construction -- (1) Stability under all forms of combined loadings, particularly for extremely large diameter-to-thickness ratio shells. (2) Stress diffusion of concentrated loads into thin shell structures taking into account effects of large deflections and internal pressure.

Strength of Pressure Vessels -- (1) Determination of the mechanics of failure so as to permit correlation with known mechanical properties of materials. (2) Determination of fail-safe design approaches to avoid catastrophic failures.

Fatigue -- No satisfactory methods of predicting the fatigue life of the structures of vehicles are yet available or even in prospect. Increased emphasis on this aspect, through an integrated research program, is recommended.

Design Optimization for Minimum Weight -- Underlying principles for the design optimization of various categories of high-speed aircraft and space vehicles must be established, suitable analysis procedures developed and new configurations invented. In addition, optimization should be extended to subsystems such as guidance and control, propulsion, hydraulic and electric equipment.

Design Criteria -- Design criteria require re-examination to provide both concepts and techniques for their application which will have more universal validity for the complex environments of advanced flight vehicles than the simple "factors of safety" of past practice.

(Continued)

ADVANCED FLIGHT STRUCTURES (Continued)

Required Research Facilities and Flight Tests

∅ Ground-Based Facilities are needed to provide adequate simulation of the various hazards of the space environment as follows: (1) Vacuum chambers of sufficient size to permit testing of realistic structural components of assemblies, not simply of small material specimens, are required. The vacuum should be "hard" enough to reproduce surface phenomena actually encountered in space. (2) The reproduction of the heating and cooling of sunlight and cold space is essential, and these conditions must be producible in conjunction with a hard vacuum. (3) The development of a "gun" is required, capable of firing simulated meteoroids at velocities substantially in excess of 20,000 feet per second. (4) A proton accelerator is needed to give 400 MEV particles in reasonable fluxes in a chamber of sufficient size so that shielding systems can be studied with validity.

Note: The panel endorses aggressive studies aimed at the achievement of the latter two facilities in particular -- including the sponsorship of heavy expenditures that will be required for construction.

∅ Flight Test Facilities will be needed to investigate the behavior of structures and materials under environmental conditions that cannot be adequately simulated on the ground. Of particular importance are:

Recoverable Satellite Laboratories to study the behavior of structures and materials in space. These studies, requiring large area exposures, advanced telemetry techniques, and a reliable recovery system should be implemented immediately, concurrently with scientific studies of the space environment for other than structures and materials research.

Lunar and Planetary Probes are essential in order to establish the atmospheric and surface environment of the moon and the planets. Television and telemetry techniques are sufficiently advanced so that significant information can be obtained and increased effort should be encouraged.

Rockets and Missiles designed for reentry data should be part of an accelerated program since it is not now possible to simulate the severe environmental conditions during reentry at superorbital velocities.

Integration of Research on Structures and Materials

A continuing program of cooperation between structures and materials research personnel is recommended.

Specific areas where emphasis is required include: (1) Structural utilization of refractory materials for sustained exposure to high temperatures. (2) The development of materials applicable to "wide-band" thermal protection systems. (3) The development of structural and insulation materials for cyrogenic tanks. (4) Improved utilization of whiskers, foils, flakes and advanced fibers in composite materials. (5) Development of structural materials of reduced density.

(Complete report, detailing many of the proposals outlined above, is now available on a limited basis. 49 Pages. Write National Aeronautics and Space Administration, 1520 H Street, N. W., ATTN: CODE BID for NASA Technical Note D-518)

* MISSILE CANCELLATIONS

The military services have spent some 2,327.5 million dollars on missile programs which have been cancelled, terminated or "reoriented" since 1944 according to official reports to Congress.

Here is a summary of such programs for surface-to-surface, air-to-surface, air-to-air and surface-to-surface missiles, along with the amounts spent:

| Project | Dept. | Type | Started | Ended | Funds (Millions of Dollars) |
|---------------------|-------|------|----------------|------------------------|-----------------------------------|
| NAVAHO | AF | S-S | March 1946 | July 1957 | 679.8 |
| RASCAL | AF | A-S | April 1946 | November 1958 | 448.0 |
| SPARROW I | N | A-A | December 1946 | December 1958 | 195.6 |
| REGULUS II | N | S-S | June 1943 | do | 146.5 |
| TALOS (land-based) | AF | S-A | 1953 | July 1957 ¹ | 118.1 |
| HERMES | A | S-S | June 1944 | June 1955 | 96.4 |
| PETREL | N | A-S | August 1944 | July 1957 | 87.2 |
| GOOSE | AF | A-S | June 1955 | December 1958 | 78.5 |
| CROSSBOW | AF | A-S | March 1953 | November 1956 | 74.6 |
| SPARROW II | N | A-A | February 1951 | do | 61.6 |
| METEOR | N | A-A | November 1945 | June 1954 | 52.6 |
| RIGEL | N | S-S | June 1946 | July 1953 | 38.1 |
| DART | A | S-S | March 1952 | September 1958 | 38.1 |
| DOVE | N | A-S | April 1944 | February 1955 | 33.7 |
| LARK | A,N | S-A | February 1945 | December 1950 | 24.9 |
| TRITON | N | S-S | November 1946 | September 1957 | 19.4 |
| PLATO | A | S-A | September 1953 | August 1959 | 18.4 |
| TERRIER (land) | A | S-A | May 1951 | September 1956 | 15.8 |
| GAPA | AF | S-A | May 1945 | 1949 | 13.8 |
| ORIOLE | N | A-A | May 1947 | January 1953 | 12.5 |
| GREBE | N | S-S | August 1944 | July 1951 | 11.7 |
| GORGON V | N | A-A | Unknown | March 1955 | 8.7 |
| Bmr Def Missile | AF | A-A | October 1955 | November 1956 | 6.4 |
| MX-794 | AF | S-A | March 1946 | July 1949 | 5.4 |
| ATRAN Guidance Sys. | AF | S-A | April 1946 | May 1947 | 4.9 |
| PUFFIN | N | A-S | February 1947 | 1949 | 4.0 |
| D-40 | N | S-S | June 1952 | 1957 | 3.7 |
| B-58 ASM | AF | A-S | February 1953 | May 1957 | 3.3 |
| WIZARD | AF | S-A | March 1946 | January 1958 | 2.9 |
| TARZON | AF | A-S | April 1945 | September 1951 | 2.7 |
| FIREBIRD | AF | A-A | March 1946 | December 1949 | 2.1 |
| LOON | A,N | S-S | December 1944 | September 1952 | 2.0 |
| OMAR | N | A-S | August 1951 | October 1954 | 2.0 |
| MX-773 | AF | S-S | February 1946 | May 1947 | 2.0 |
| MX-774 | AF | S-S | May 1946 | June 1947 | 2.0 |
| Air Launched Decoy | AF | A-S | October 1953 | January 1956 | 2.0 |
| ZEUS (AAP) | N | S-A | Unknown | Unknown | 1.9 |
| MX-772 | AF | S-S | March 1946 | June 1947 | 1.9 |
| SPARROW X | N | A-A | May 1957 | December 1957 | 1.2 |
| MX-1593 | AF | S-A | 1951 | 1954 | 1.9 |
| GOBI | AF | A-S | April 1946 | May 1947 | 1.2 |

¹ Transferred to Department, Army.

Note. - Projects on which less than \$1 million were expended have been excluded.

I N V E N T I O N S W A N T E D

Here is another in a series of new reports on inventions wanted by the military services or various Government agencies.

Subscribers interested in any of these research tasks may write Service Department, Washington SCIENCE TRENDS, 1120 National Press Bldg., Washington 4, D. C. You will be furnished with the official Problem Number and Title, and information on how and where to submit proposals.

- (✓) RADIO-PROOF BLASTING CAPS -- This requirement calls for an inexpensive and efficient electric blasting cap which cannot be initiated by electromagnetic radiation from radio or radar waves or gamma rays given off by radioactive sources. Also, radioactive particles should not initiate the blasting caps.
- (✓) MISSILE IMPACT MEASUREMENT -- This device should be capable of measuring and recording high accelerations which are inherent with missile impact. The device should be self-contained within the missile -- and should be recoverable.
- () INFANTRYMAN'S RANGE FINDER -- The Army requires a range finder for the combat infantryman which should permit quick range determination of a vertical target of known dimensions while possessing an accuracy of no less than 5% of true range up to 350 meters. This device should be small, lightweight and relatively inexpensive. The ability to determine range at night should be incorporated.
- () TITANIUM COATING -- The Government is looking for a method of coating titanium on copper screen (.010" to .020" thick) to protect it from corrosion in liquid ammonia solutions. The screen must retain its good electrical characteristics.
- () AIRCRAFT FUEL SAFETY SYSTEM -- This system should be capable of chemically or physically inerting aircraft fuel upon impact -- automatically, instantly and positively -- in tanks, carburetor and induction lines. This must be done by changing the chemical or physical characteristics of the fuel or by instantly ejecting the integral fuel system and components prior to ignition, to a safe distance. The system must be fool-proof, working only in case of accident and never while in normal flight or combat. The system must be lightweight and applicable to rotary as well as fixed-wing aircraft.
- () CHLORINE BATTERY CONTAINER -- This lightweight material for use as a battery container must be capable of withstanding hot (212°F) moist chlorine under pressures of 250 psi without deformation.
- () COLD WATER DETERGENT -- The Quartermaster Corps would like to see improved methods for effective cold water laundry procedure in its field laundries. A procedure, and a detergent, using water ranging from 35°F to 80°F, is required.
- () MANOMETER LIQUID -- A stable, non-corrosive liquid for manometer use is required. It must have uniform density variation at temperatures over the range of 60° to 120°F, with a specific gravity of about 5.0.

P U B L I C A T I O N C H E C K L I S T

- () CIVILIAN POWER REACTORS, a comprehensive survey published by the Atomic Energy Commission on the Economic Potential and Development program in the civilian power reactor field as of 1959. Details status and future of various concepts and general research and development in this field. 98 Pages. 70 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Pub. TID 8517)
- () FERRITE PROPERTIES, a report on means of measuring the dimension changes of ferrites upon magnetization, with details of proposed apparatus for performing dynamic measurements. 43 Pages. \$1. (Write OTS, U. S. Department of Commerce, Washington 25, D. C. for NBS Technical Note No. 49)
- () ELECTROREFINING BERYLLIUM, a report on preliminary experiments in which thin platelike crystals of beryllium metal were producing by electrolyzing technical-grade beryllium beads. 9 Pages. Single Copies Free. (Write Publications-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigation No. 5581)
- () AEROSPACE CAREERS AND SCHOLARSHIPS, a list of reference sources on this subject, primarily for the use of educators. 6 Pages. Single Copies Free. (Write Publications Inquiry Unit, U. S. Office of Education, Washington 25, D. C. for Pub. OE-26005-1)
- () INFORMATION PROCESSING, the complete proceedings of the first International Conference on Information Processing, Paris, covering methods of digital computing, common symbolic language, translation, future computer techniques and similar subjects. 600 Pages. \$25. (Write UNESCO Publications Center, 801 Third Avenue, New York 22, N. Y.)
- () HIGH-TEMPERATURE ALLOYS, selected references prepared by the Defense Metals Information Center on the production of high-strength and refractory metal alloys by powder-metallurgy techniques. 4 Pages. 50 Cents. (Write OTS, U. S. Department of Commerce, Washington 25, D. C. for DMIC Memorandum No. 47)
- () CEMENTED CARBIDE PRODUCTS, a proposed simplified practice recommendation listing shapes, sizes, and grades of cemented carbide blanks, inserts, die nibs, tools, etc. Includes a new uniform system for designating such products as well as a list of trade terms and definitions. Single Copies Free. (Write Commodity Standards Division, U. S. Department of Commerce, Washington 25, D. C. for SPR-4652 - Cemented Carbide Products)
- () HYDROFOIL DEVELOPMENT, a report and a summary of Naval research progress in the development of hydrofoil craft for civilian and military applications. 9 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Bldg., Washington 25, D. C. for Report Serial e)
- () PLASTICIZERS, a report showing that U. S. output of all plasticizers last year reached an all-time high and including a variety of other production and sales statistics on these chemicals. Single Copies Free. (Write Information Office, U. S. Tariff Commission, Washington 25, D. C. for Plasticizers -- Preliminary Report)

